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***DESIGN PROCESS I-15
EVALUATION
DESIGN/BUILD PROJECT
1999 FINAL REPORT***

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UDOT RESEARCH & DEVELOPMENT REPORT ABSTRACT

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16. Abstract <p>This report describes the design process used in the I-15 Design/Build Project in Salt Lake City by Wasatch Constructors and the Utah Department of Transportation (UDOT). This study documents modifications made to the process and the organizational structure from the beginning of the project through completion of the design phase.</p> <p>The report outlines the staffing level requirements for UDOT and the consultants involved in the project. In addition, numerous procedural innovations, including financial incentives, the use of Task Forces to provide direction and the sharing of value engineering savings with the contractor are discussed. Other areas addressed are the physical facilities requirements, management requirements, computer automation requirements/software, and QA/QC processes.</p> <p>Other topics addressed in the report include submittals and review dealing with design changes and agreements. Problems encountered from value engineering through scheduling are reviewed as is the lessons learned in owner involvement, reviews, audits, etc.</p>					
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INTRODUCTION

This report is the second and final review of the design process used in the I-15 Design Build project by Wasatch Constructors and UDOT. A preliminary evaluation and review of the organizational structure established for the design process was presented in the 1998 Annual Report prepared for this project. This second examination is intended to document modifications made to the organizational structure and process during the past year and to evaluate the process upon completion of the design phase of the project. Final design packages were submitted for all segments of the project in November 1998 and are being reviewed and approved by UDOT. It is anticipated that the final acceptance of all design documents will be completed by June 1999.

This report addresses the design process used on the project. Other reports have been prepared covering the selection process used by UDOT for selecting the design/build contractor, initial plan for the design and the quality assurance and quality control (QA/QC) processes used by Wasatch Constructors on the project. In addition to these reports UDOT intends to prepare evaluation reports covering topics such as the Award Fee, partnering, use of innovative design and construction methods and materials, the use of performance specifications, and public relation programs used on the project. Annual reports will be published which contain the results of the evaluations and a final report summarizing the entire project is scheduled for publication in 2002.

This report is divided into sections which address various issues identified during this review. At the end of this report conclusions and lessons learned are presented.

MANAGING THE DESIGN PROCESS

Notice to Proceed was issued to Wasatch Constructors by UDOT on April 15, 1997. The design process began in May 1997 and was completed by November 1998, approximately four months earlier than originally proposed by Wasatch Constructors. The design process produced nearly 14,000 plan sheets along with supporting specifications and design documents.

The following sections describe the staffing levels developed by both UDOT and Wasatch Constructors to complete their portions of the project.

Staffing Level Requirements (Wasatch Constructors)

After Notice to Proceed, Wasatch mobilized design staff using the resources of their prime design consultants Sverdrup Civil, Inc. and DeLeuw Cather, plus 18 subconsultant firms. The decision was made to locate as many of the staff in one central location as possible. A large office building was leased and equipped to house both the design staff, the construction administrative staff and UDOT staff. This location came to be called the 'Hub'. At its peak there

were a total of 340 design staff on location in the “Hub” during the most intense design period. An additional 140 off-site engineers, mostly bridge designers, were used to accelerate the design elements. The design team had difficulty attracting enough project bridge designers to move to the ‘Hub’ so a large portion of the bridgework was completed in outside offices. Additionally, some of the other work elements were completed in outside offices during 1998 when the design was accelerated, requiring additional design staff.

The 340-peak staff level was a substantial increase in the Design/Build Consultant’s staffing level used during the proposal stage when approximately 75 design and construction personnel worked on the proposal for the six months during the selection process. Additionally, cost-estimating staff was provided by the three construction contractors involved in Wasatch Constructors.

Once the design packages were completed and submitted to UDOT for final approval, the Wasatch design staff was reduced. During the approval phase 40 to 50 design staff were maintained to make corrections to the final plans. After final approval is received on the plans, the design staff will be further reduced to an expected staff of no more than 20 for design support services during construction. In addition the designers are furnishing staff for the quality assurance and final design review groups. The staff is distributed as follows:

- Construction Quality Assurance (QA) – One for each of the three segments plus an overall QA Manager
- Final Approval Group – 8 to 10 people
- Field Design Group – 20 people

Staffing Level Requirements (UDOT)

The I-15 UDOT Project Team staffing levels of 55 to 65 people have remained fairly consistent throughout the duration of the project. The peak staffing period occurred during the right-of-way plan development and acquisition process. During the major design phase about 1/3 of the UDOT staff was involved in the design oversight process. As the design activities have concluded the staffing has evolved to include more construction personnel. As of June 1999, about half of UDOT’s staff are responsible for construction oversight and the rest are involved in administration, management and design.

Due to legislative limitations, UDOT was limited on how many staff could actually work on the project. Since UDOT could not increase their total number of permanent full-time employees to work on this project, UDOT hired several consultants to assist and support them on the project. Parsons, Brinkerhoff, Quade and Douglas (PBQ&D) was hired as the primary consultant to provide support for UDOT’s staff. UDOT also hired other firms including a public relations firm and testing laboratory. Together the group functions as a fully integrated I-15 Project Team. Many of the team assignments have been composed of a mixture of UDOT and subcontractor staff, depending upon the requirements of the assignment. However, all management and construction oversight is completed by this team made up of UDOT and consultant staffs. PBQ&D assists with administrative, technical design reviews, contracting, right-of-way, utilities, construction oversight and railroad coordination activities. UDOT and another subconsultant

handle public relations activities. Overall, approximately one-half of the I-15 Project Team is comprised of UDOT employees with the rest made up of consultants.

Procedures

The project has allowed for numerous procedural innovations, including financial incentives that are a key component of the Design/Build contracting process. A prime example of a significant procedural change has been the use of a Task Force process for review in place of the more traditional detailed review process used by most owners. Detailed reviews and QC/QA roles were assigned to the contractor with audits performed by the owner to monitor compliance. Location of the design, contractor and owner staff at one single location was another significant procedural change not previously used by UDOT. Use of performance specifications was also a significant departure from normal procedure.

UDOT and Wasatch used a Task Force process to provide direction and review to the design teams. The Task Force meetings were held each week and consisted of representatives of the Contractor and his designers, UDOT and FHWA. UDOT staff attended each session and provided input into the design at this stage. In these meetings design approaches, questions and criteria were discussed and decisions made as to acceptable solutions. Minutes of these meetings were prepared and reviewed by all present. It was during these review meetings that UDOT staff was able to monitor what the contractor and his designer's were doing and review design criteria and solutions. They also provided input on any design issues. Some Task Force meetings were discipline oriented where a design criterion was discussed. Others were segment related where specific segment related design issues were discussed and resolved. Copies of plans, specifications and design details were made available to all parties prior to the Task Force meetings so that they could be examined prior to the meeting and any questions addressed during the meeting. Copies of the minutes serve as the record of the decisions and are still referred to when field questions are encountered.

Another procedural example was the sharing of value engineering savings with the Design/Build Consultant. The Design/Build contract allows the Contractor to receive 50% and UDOT to retain the other 50% of any savings achieved. The contractor agreed to share a quarter of their portion with the prime design consultants. However, these saving incentives were not shared with subconsultants to the prime design team.

Physical Facilities Requirements

UDOT, the Contractor and the Designer were all located in the same building referred to as the "Hub". From everyone's perspective, this was crucial for the success of the project. This co-location enhanced communication among all parties and facilitated in coordination; i.e., time was not wasted sending faxes, commuting to meetings, trading telephone calls, etc. Everyone was also connected electronically through the same computer network system, although secure areas were provided for each party. If there were any questions, the answers were just a few steps away.

During the peak period of design, approximately 140 designers were located off-site. Consultants were used throughout the country, which made communication more difficult. Not

only was it harder to keep the off-site designers up-to-date with the latest facts and information, they did not have the benefit of easy access to UDOT or the Contractor. This caused more time to be spent by the on-site design and management groups to coordinate these off-site work tasks. Since there was no more space left in the building to house additional designers once it was decided to accelerate the design process by four months, this additional staff was allowed to be added at remote office locations.

UDOT's I-15 Project Team and management staff were all located in the "Hub". This was viewed as critical in maintaining the aggressive design schedule by reducing delays in going back to headquarters to obtain approvals or support. UDOT's project staff was authorized to make most of these decisions. They were also involved on a day-to-day basis and were available for questions and coordination with the Wasatch Constructor staff.

Management Requirements

The contractor chose to use a system called Earned Value Reporting to control his operations. Because the contract called for a lump sum bid for the majority of the work it was viewed as necessary by the contractor to break the project into smaller sections. Contractor staff felt that this was absolutely required to effectively manage this kind of project. Activities were tied to milestones with each milestone having work-hours associated with them. Increments of 40 hours were used. The system was integrated to include both design and construction activities. The contractor and his engineers used electronic time card reporting so the hours spent on the project were tracked weekly (i.e. "real-time"). In addition, overhead direct costs were paid as a lump sum to reduce the amount of tracked cost items.

The Partnering Program was viewed by both UDOT and Wasatch as essential on this project. UDOT recommended an extensive partnering process as part of the contract requirements. The contractor responded to this recommendation by establishing a formal process for partnering, including regularly scheduled partnering meetings with UDOT at several management levels. The partnering escalation process was very important and was used extensively to resolve project concerns. However, during the design process, there was only one single instance when an issue had to go to the top of the escalation process. The reason given was that it was of a legal issue dealing with wage determination that could not be addressed by anyone other than the executive director of UDOT and his Wasatch counterpart.

To manage the design efforts, procedures to track drawing lists, master plan sets, revisions and versions were established. The Task Force groups used detailed meeting minutes to keep track of issues and decisions. Design issues were discussed in weekly meetings to ensure their timely resolution and maintained on a list until resolved.

To manage the labor expenditure, the design/production manager had a financial manager counterpart to track this information. The design/production manager was responsible for assigning resources and meeting schedule. The financial managers were responsible for cost budgets. However, the production managers were ultimately in charge of ensuring that the work was completed within the allotted funds.

Computer Automation Requirements/Software

The Design Group used a single design and drafting software. This was a requirement for everyone involved in the project. The selection of the software was based on UDOT's requirements to ensure compatibility with their own system. MicroStation and InRoads was the actual software used for the project.

A CADD Task Force was established at the beginning of the project to address CADD issues. To get this system up and running was fairly easy and not a schedule issue.

A program called *Resymbol* (a Sverdrup program) was used to make sure the CADD files met project requirements for drafting consistency. This program was used to review all submittals, especially those from external consultants. For the most part, this process worked fairly well. However, in one instance it took approximately 360 hours to fix one of the submittals and bring it into conformance with the CADD standards.

In addition to the design software, the Design/Build Team used *Expedition* to manage the project's electronic communication, including scheduling and timely distribution of the meeting minutes. This system was also used to track all communications.

QC/QA Process

Wasatch was required to develop a Design Quality Management Plan (DQMP) and have it approved by UDOT. The initial development process was a big challenge requiring several months to complete. Once developed it took three to four months for Wasatch to fully implement.

Wasatch's Quality Assurance Manager performed over 7000 audits in 20 months. The contractor had one single person assigned to perform all of the QA audits. These audits consisted of checking that reviews and procedures outlined in the DQMP had been completed and documented and that the QC process had been completed.

UDOT conducted audits during the design process on a weekly basis. On average, UDOT conducted between 9 and 30 audits per month as part of their weekly oversight reviews. Their goal was to audit 10% of all designs.

UDOT used a two pronged approach to provide design oversight. These consisted of:

1. Audit of the Contractor's actual QC/QA process and comparing it to the DQMP.
2. Weekly Task Force meetings with the contractor's personnel to discuss design issues and perform oversight review of plans and specifications.

Figure TS1 shows a graph of the number of oversight reviews conducted monthly between December 1997 and December 1998. They averaged about 115 reviews per month.

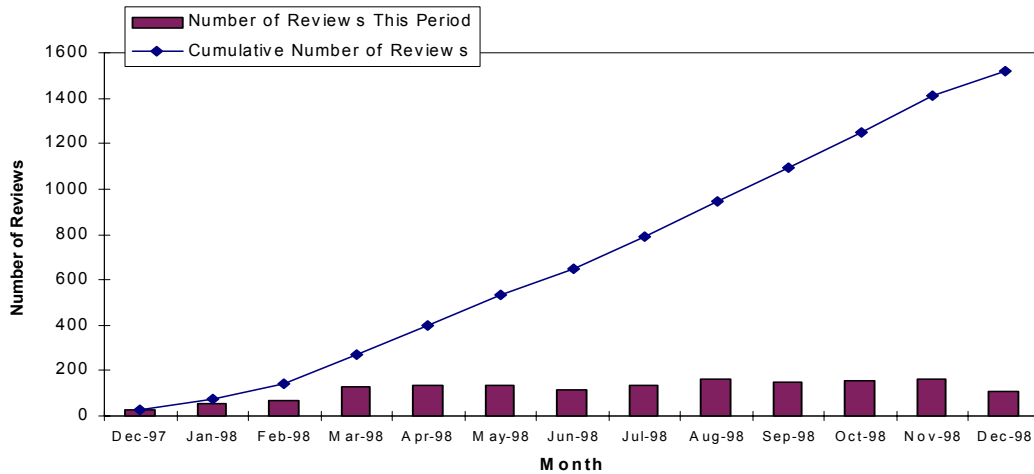


Figure TS1 - Number of Oversight Reviews Performed

UDOT implemented an audit tracking file that began in December 1997 to document how many audits were performed and their status. No detailed records of the audits prior to December 1997 were kept. UDOT's involvement was basically limited to weekly oversight audits. Detailed reviews were limited to possibly less than 5% of what would normally be performed by an owner. Figure TS2 shows the extent of audits performed during the design process.

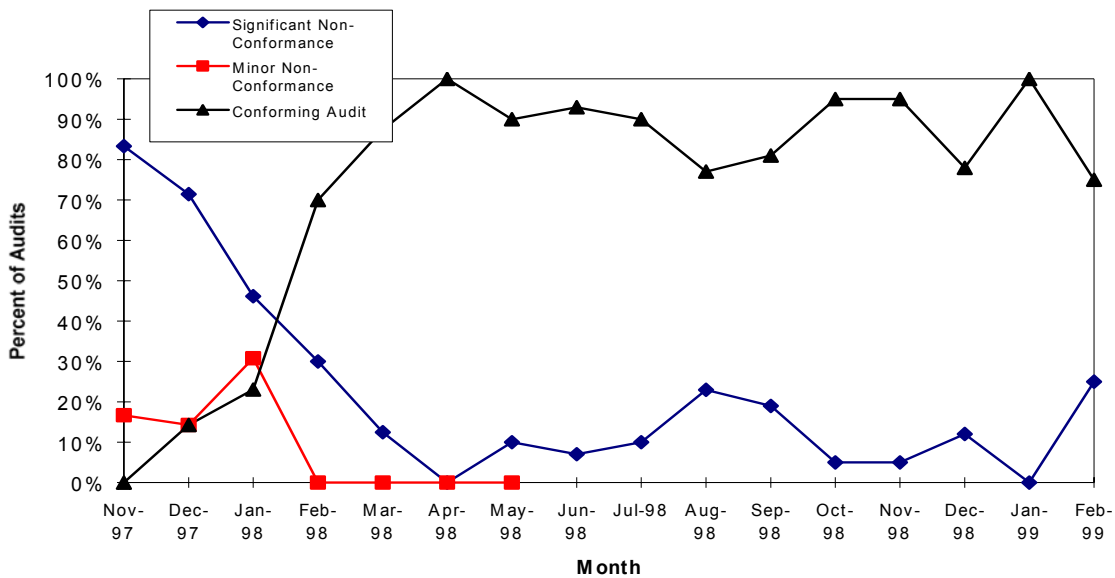


Figure TS2 - Design Quality Audits

UDOT's Auditor reviewed Wasatch audit records of the QC/QA procedures and then prepared a report on non-conformance issues. UDOT's Technical Support Manager then evaluated the significance of non-conformance issues. Major non-conformance findings that could affect the award fee were returned to Wasatch for response. Monthly audit results were considered in the Award Fee evaluation.

Some non-conformance issues were raised on non-critical issues such as failure to use the exact process of review specified in the DQMP. These issues were generally remedied by additional training. The stringent process established by the Contractor created several of their own non-critical and non-conformance findings. A more simplified process would still have been acceptable contractually and may have avoided some of the non-conformance issues. However, once the plan was adopted by Wasatch, UDOT was obligated to enforce the process in the audits.

Wasatch required that completed QC process checks were made at 30%, 65%, 90% and 100%. The level of the QC process checks for each of these submittals were as if the plans were 100% submittals. This was time consuming and beyond the contract requirement of 50% and 100%, but the Contractor still required that QC be done on all submittals.

The QC process was generally viewed as adequate. There was difficulty in the beginning getting everyone to follow the procedures and is reflected in the data shown on Figure TS2. This was rectified by additional training of the Design/Build Team on the procedures and requirements of the QA plan.

SUBMITTALS AND REVIEWS

Submittals

There were design reviews made at the 30%, 65%, 90% and 100% design level. The contract required only two formal reviews, one at approximately 50% completion of design and the final 100% with a submittal. The other reviews were proposed by Wasatch as progress reviews and were made a part of the "Over the Shoulder" review process. Division of the project into design segments by Wasatch required 13 separate final submittals: ten design section submittals, one corridor wide (standard plan) submittal, one Automated Transportation Management System (ATMs) submittal, and a final/sealed plans submittal.

The number of sheets per section submittal varied from 400 to 1500 sheets. The total number of sheets submitted was approximately 14,000. There were also approximately 350 standard drawings produced.

In addition to these submittals, there were additional submittals for constructability reviews and staged construction. These varied throughout the process and were generally a part of the total submittals.

Reviews

For the formal final submittal, the ten design section submittals were scheduled one week apart with allowances made for Christmas and New Year's Eve holidays. By contract UDOT agreed to complete a one-week review and return written comments to be followed by a subsequent Comment Resolution Meeting. The Design Group was then required to resubmit final corrections two weeks later. Because of the many comments made for all sections, a final submittal was made at the end of the review period to ensure all issues were adequately addressed.

UDOT purposely staffed the Oversight Team to require that the Design/Build Consultant perform the detailed reviews normally performed by UDOT. UDOT did not have the staff and time to complete these detailed reviews. It was also intended that the Engineer of Record assume the detailed design review responsibility when the documents were signed. UDOT performed reviews to determine fatal flaws in the process or methods to be used, but not the detailed technical reviews.

For the final review, each section averaged 200 comments. This was more than what the Design/Build Contractor expected. About half of these comments were editorial with no additional design action needed. UDOT also commented on items that had not been commented on previously even though it was anticipated that only an assurance check would be performed to ensure that previous comments had been addressed.

For the final review submittal, the Design/Build Team submitted one package weekly beginning the end of November 1998 for a total of twelve submittals, with the last one scheduled for mid-March 1999. A thirteenth package is intended for a 'clean up' submittal at the end of the process to incorporate any comments that effect all of the submittals. After the final review, UDOT will send a final letter of design approval although the design will not be formally accepted until after the final construction is completed and accepted.

The "over-the-shoulder" review process used by UDOT on this project was a new concept for them. At first it was expected that this would result in opportunities to only do a cursory review of the project. As it was implemented, and using the Task Force meeting process, this resulted in having UDOT staff intimately involved in the design process at much earlier stages than is typical of a design project. The Task Force meetings offered opportunities to have UDOT get involved at very early stages of development of criteria and plans, where decisions were made as to how to proceed. With this exposure to the design it became much more efficient to review the project because UDOT staff had been involved throughout the process and were intimately familiar with the design that was occurring. This daily involvement with the design team resulted in having UDOT staff very well informed about the design and in agreement with the design decisions that were used on the project.

Of the 142 bridges on this project, 134 were designed by the Design/Build Team. The other eight bridges were sealed plans included as part of the original bidding documents. The schedule for bridge review was different from the roadway reviews. Each bridge had a two-week final review by the two person UDOT bridge review staff.

Field Design Changes

There have been approximately 150 field changes per month during the construction period. This number has remained fairly consistent throughout the project. Field changes occur in three types.

- Field Design Change (FDC): a change initiated in the field not to build the feature as designed or to make a modification to meet either field conditions or equipment and labor capabilities.
- Request for Information (RFI): Clarification of design.
- Nonconformance Evaluation (NCE): Designer input on how to resolve non-conforming work without removing and replacing. The Quality Control Group (Field or Design) initiates a NCE.

Many of the field changes were associated with embankment, surcharge and construction staging issues. Figures TS3 through TS6 quantify some of these changes as of March 1, 1999.

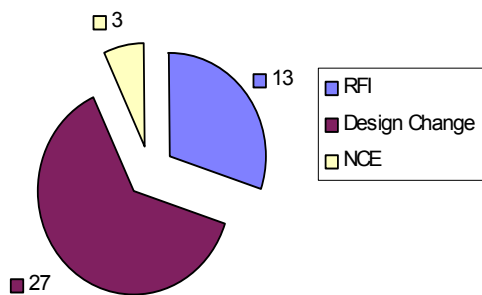


Figure TS3 - Field Design Memos Downtown Segment

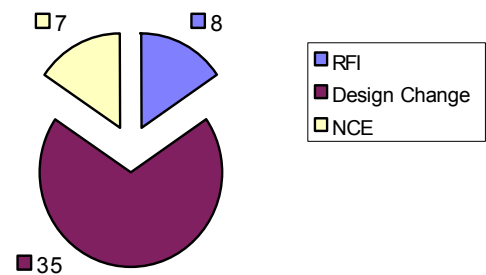


Figure TS4 - Field Design Memos Jordan Segment

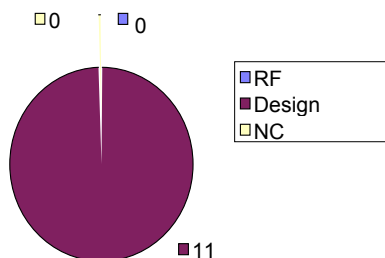


Figure TS5 - Field Design Memos ATMS Segment

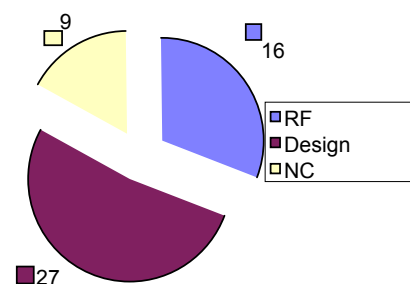


Figure TS6 - Field Design Cottonwood Segment

A process to handle plan changes during construction was developed. It was important that UDOT stay involved and informed regarding field changes. One way of keeping UDOT up-to-date was to have weekly post design service meetings to discuss field design changes. If UDOT determined that construction was not in conformance, they issued an Owners Monitoring Notice (OMN). These items were tied to criteria in the contract and given to the Quality Control Group (QCG). If the QCG agreed, a written Nonconformance Evaluation Report was provided. The item was then revised, removed and/or replaced. If the Quality Control Group disagreed, the problem escalated. This process was usually resolved between the Contractor and UDOT with very few instances escalating. This process was developed after initiation of the project and replaced an earlier problem resolution system that did not function satisfactorily.

Technical Agreements

Wasatch and UDOT, as a result of a separate Memorandum of Understanding (MOU), further expedited the change process by agreeing to use Technical Agreements. The MOU stated that the contractor was allowed to make changes to the contractor's proposal, performance specifications or standard specifications as long as UDOT agreed that the changes were equal to or better than the original contract requirements. The Contractor requests a change, and if UDOT concurs a Technical Agreement is developed documenting the change. Once signed, this becomes part of the contract and modifies the original proposal. This allowed technical staff to proceed with reasonable changes and avoid delays associated with lengthy approvals. Figure TS7 reflects how many Technical Agreements were processed during 1998.

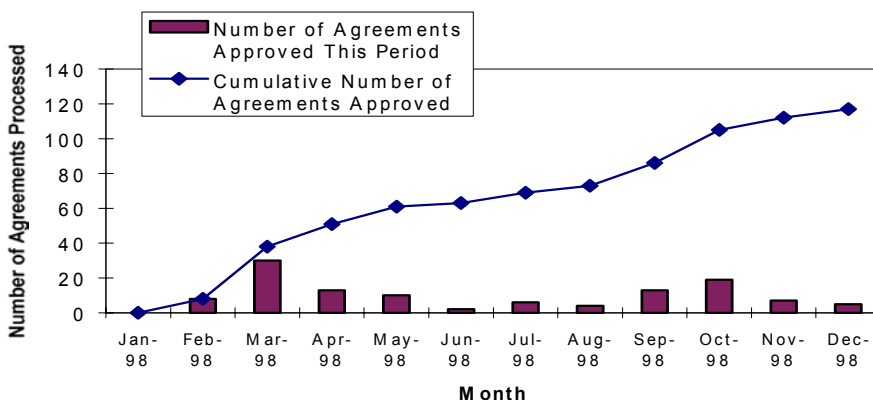


Figure TS7 - Approved Technical Agreements

EARLY ACTION ACTIVITIES

Utilities

Early identification of existing utilities was very helpful. UDOT prepared master agreements with the utility companies prior to the Notice to Proceed on the Design/Build project which identified who would design, review and construct utility relocations and betterments, and who

would pay for the work items. This was established before the project began. The Contractor then negotiated individual utility construction work agreements during the Design/Build stage. However, UDOT is still responsible for all the final contracting and payments.

There were approximately 1500 utility crossings, with 800 conflicts identified for relocation. The Contractor generally performed design and construction with the utility companies reviewing and approving plans and construction. The Contractor hired two separate engineering companies who had previously worked with the utility companies to complete the designs in accordance with the utility Companies requirements. Two utility companies did their own design and construction - US WEST and Utah Power. These companies had previously commenced advance work on their own facilities and wanted to complete their own work.

The project paid for all conflicting utility designs and relocations. The cost of utilities was bid as a Lump Sum with the burden of delays shared equally between UDOT and the Contractor. The Contractor was reimbursed for all identified utilities that were impacted. If the Contractor was able to reduce the number of relocations, the Contractor's reimbursement was not reduced which provided an added financial incentive to minimize conflicts. Betterment to the utility's facility was a utility company(s) fiscal requirement and was not a part of the project's expense. Payment for betterments was made by the appropriated utility through UDOT to the contractor.

Right-of-Way

UDOT was responsible for all right-of-way acquisition and began acquisition approximately nine months prior to issuing the Notice to Proceed. The identification of the required acquisition properties was provided to the contractor prior to the Request for Proposal. UDOT committed to acquiring one-third of the parcels prior to the Notice to Proceed and the balance on a schedule provided to the Contractor. Right-of-Entry was obtained for the remaining parcels so the Contractor could proceed with work prior to the completion of the acquisitions. A total of 350 properties were acquired.

The Contractor was responsible for obtaining all construction easements, including those required for staging areas and haul roads. He could however, elect to have UDOT acquire these and reimburse UDOT for any costs. He elected this option.

There were problems encountered during design with the right-of-way as shown on the plans. Apparently, the detailed right-of-way research was performed on the areas where anticipated parcels were required by UDOT. In other areas the right-of-way was shown through a minimal amount of record research and was shown primarily as a line on a drawing. This was a concern to the design team in trying to confirm that they were staying within the right-of-way as they were completing design throughout the corridor. Wasatch was responsible for the cost for any of the additional right-of-way required beyond that which was committed to by UDOT. It would have been better for the designers had UDOT tied down the right-of-way information more precisely on the drawings, either through reference monuments or ties to section corners so that the designers could have more confidence in the precise location of the right-of-way shown on the plans.

Drainage

Quantities of permissible discharge flows (e.g., discharge restrictions into the Jordan River and other channels) were established by UDOT prior to release of the Design/Build Request for Proposals. UDOT verified that these quantities were reliable for bidding and construction purposes and documented them in the Project Drainage Report. Any agreements and permits required were completed by UDOT prior to or during construction.

Mapping

UDOT furnished a complete digital terrain model with contours of the entire corridor. This was done prior to the award of the project. This was available in digital form to all proposers during the development of their proposals. The Contractor thought this was a valuable resource for all of the design teams in that they could rely upon solid and accurate mapping information. The Contractor's consultants did some supplemental surveying to confirm specific locations but generally the mapping furnished with the design was adequate for most of the design work

Hazardous Material

Hazardous material investigations were performed prior to the Request for Proposal. From this investigation, UDOT established a budget and requested bids on quantities from the Contractor. The hazardous material quantities were bid using unit prices that reduced the risk to the Contractor. These unit prices were renegotiated if estimated quantities were found to be significantly different than estimated. Figure TS8 reflects charges as of the end of 1998.

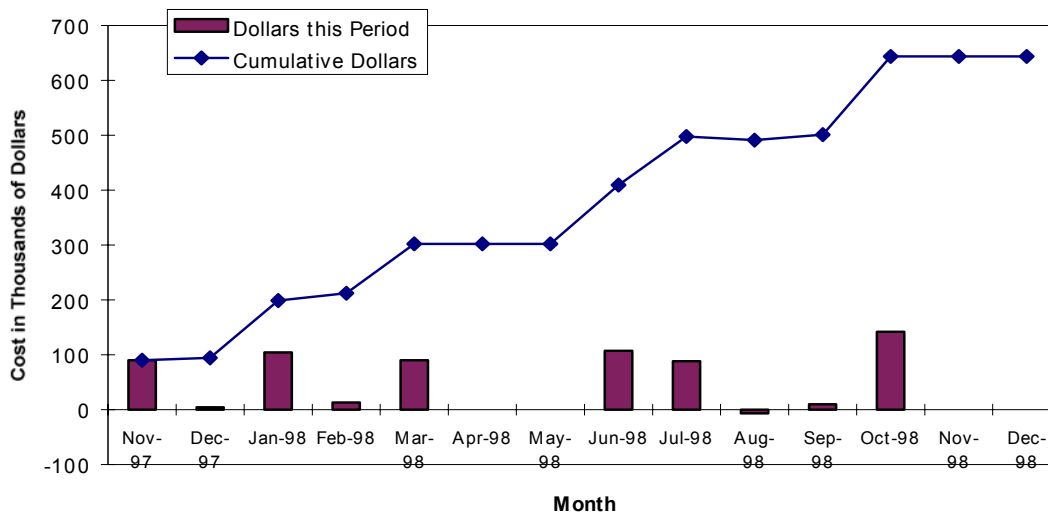


Figure TS8 - Hazardous Materials Remediation

Permits

All environmental permitting was completed by UDOT prior to the award of contract. By contract UDOT required that the Contractor conform to the conditions of the permits. Permit information was provided to the Contractor at the time of proposal.

Geotechnical Investigations

Extensive geotechnical investigation information was provided by UDOT to each team prior to award of contract. This consisted of an extensive amount of exploration work, soil log information and all testing that was accomplished by the geotechnical firms. No interpretation of the information was provided, however. This was left up to the design team. The expectation was that this would expedite the design of the project because they would already have the geotechnical information needed for design.

Generally the geotechnical information furnished was valuable to the design teams. They did perform additional investigations beyond what was furnished but felt that the information provided was also of great value.

One of the design teams indicated that much of the geotechnical investigation work performed for the viaducts was not as useful as it could have been since the contractor decided to relocate piers. This invalidated the site specific geotechnical investigation performed at the locations of piers based upon UDOT's expectations of where they would be located.

The contractor has relied extensively upon the use of wick drains, mechanically stabilized earth (MSE) walls and geo-foam construction on the project to try and meet some of the geotechnical challenges of the project. Wick drains were used under many of the fill locations to accelerate the consolidation of soils and shorten the construction time staged. Staged MSE walls were used extensively to help compensate for the expected large settlement that would occur on the high fills and also to accommodate staged construction. They used geo-foam in locations where it was determined that consolidation would not be achievable within the time frame required or where there were conflicts with utilities and relocating the utilities would be too expensive or difficult. The purpose of the geo-foam was to reduce the weight of the fill thus decreasing the consolidation time that could be expected under the fills.

Railroad Work

Although UDOT negotiated the original corridor-wide master agreement, all railroad permitting activities are being completed by Wasatch. Any costs incurred due to delays by the railroad will be shared equally between UDOT and the Contractor.

PROBLEMS

Value Engineering

The potential benefits of value engineering were limited on the project. The contractor's incentive was time driven. Any modification to the proposed plan that resulted in requiring more time to construct the feature was treated as a disincentive to use value engineering. The contract provided an incentive to use value engineering on alignment changes by agreeing to share any savings with the contractor on a 50/50 basis. The Contractor, in turn, agreed to share a portion of his savings with the design consultant (1/4 of his savings). However, the subconsultants to the prime design team were not included in this incentive. Also, because a lump sum contract was used on the project the incentives for value engineering were limited to changes affecting the alignment.

Because the project is so schedule driven the effects of value engineering were reduced in practice. Any value engineering change was evaluated on both the basis of the costs that could be saved and the impacts to the schedule any changes would require. Generally, changes resulting in an extension of the schedule were not implemented, even if there was a cost savings associated with them. Delays to schedule were viewed as more critical than savings in costs. Since subconsultant design teams were not directly rewarded for value engineering efforts they did not emphasize value-engineering solutions.

Development of Standards and Plans

Wasatch developed standards and plans that were intended for use by designers in completing the plan sets. More than 350 standard plans were developed for commonly used details of the construction. The standards presented the process and quality standards intended for each plan set to provide uniformity in design and assure that similar situations were treated the same way for ease in construction. Unfortunately, the development of the design standards and standard plans occurred at the same time that many of the designs were begun. This resulted in many changes to those early plans once the standards were developed. This could have been avoided or reduced had they waited until the standards had been completed. Wasatch had thought that they could use many of UDOT's standard details in their design but discovered that many of the details they wanted to use had either not been developed by UDOT or Wasatch wanted to use a different detail.

Wasatch indicated that they probably could have saved some time and costs had they concentrated early in the project on development of these design standards and plans. This would have necessitated some delay in the start of design and Wasatch had elected to begin design as soon as they could and make the changes once the design standards were fully developed. This did not seriously affect the schedule and Wasatch still completed the design ahead of their planned schedule but it did result in some reworking of the plans.

Performance Versus Prescriptive Specifications

UDOT prepared several performance specifications for use on this project. They also referenced their standard specifications, which are prescriptive, for several items not covered by the

performance specifications. Wasatch had some difficulty in using this mixture of specifications because they felt that the prescriptive specifications limited their ability to provide innovative solutions to resolve problems. They much preferred the performance specifications because these results oriented specifications permitted the contractor to accomplish the design or construction in a manner that best suited the equipment, material or methods he wanted to use. Wasatch recommended that owner's consider providing as much flexibility to the contractor as possible to permit him to use innovative means and methods to complete his work.

Constructibility Reviews

UDOT had expectations that they would benefit from use of constructibility reviews during the design process resulting in significant improvements in the designs. UDOT found that this did not occur as often as they expected. Also, subcontractor designers were often not included in these types of reviews lessening their potential benefit.

Engineer of Record

UDOT expressed some concern about the fact that the services of the engineers of record who prepared, stamped and sealed the drawings were not extended through the construction of the project. Generally, the engineers of record left the project after design was completed. The result is that field changes are reviewed by the construction support group and changes made without being able to consult with the engineer of record who prepared the original drawings. One recommendation that UDOT made was that on future contracts the engineer of record be required to remain on the project in a construction support role through the construction phase.

Accelerated Construction Schedules

One of the major conflicts noticed between the designer and the construction personnel has been the use of accelerated construction schedules by the contractor. Often times the contractor required early submittals on the design of walls, for example, when the design had not been developed completely enough for the designers to be confident about what the wall designs required. This caused difficulty in releasing early construction items to the contractor in the time frame that he wanted. This placed all of the retaining wall designs on the critical path schedule. The design teams tried to standardize many of the wall details and designs to attempt to alleviate some of this problem but were not able to resolve all of them. Universally the designers indicated they would have preferred more time to more completely develop the retaining wall designs prior to releasing them to the contractor. This has required that some walls be modified in the field after some problems arose with walls constructed in the wrong location. Fortunately it has not proven to have a significant negative impact on the project.

LESSONS LEARNED

Consolidated Office Location

Having all of the Design/Build Team located in the same location was vital in meeting project schedule. Generally, the consensus among UDOT and Wasatch was that there was no other way to do this project on this time schedule. Time was not wasted transmitting faxes, commuting to meetings, trading telephone calls, etc., since everyone was connected electronically. The Contractor stated that this should be a requirement of the contract. In addition, the Contractor should plan for expandability of office space. With UDOT, the Contractor and the Design Team all located within the same location, it was very easy and efficient to address questions and issues.

Advantage of Task Force Meetings

It has helped to have UDOT be able to “speak up” as a problem was encountered. This allowed an issue to be dealt with before it became a problem. The Contractor acknowledged that having the Owner’s acceptance/approval as things went along was helpful, and also reassuring that things were proceeding as expected and not waiting until the end of construction. The Task Force meeting process facilitated this interaction.

Preliminary Design Level

Both UDOT and the contractor felt that less preliminary engineering could have been done for this project. However, the design group felt the level was sufficient. The biggest problem associated with the level of design was with the “sealed” plans included in the project. Because these plans were a complete sealed design, UDOT assumed the responsibility for the design. There were field changes that had to be made to the plans and this complicated the Change Orders process. The owner has recommended that sealed documents not be included in future projects because of this.

For the Design/Build process, basic geometry and typical sections needed to be established. This project also had the requirement of staying within the identified right-of-way. Any changes to the basic geometry and impacts that required additional right-of-way would then become the responsibility of the Contractor for acquisition. This approach has worked effectively for this project thus far.

Use of Design Standards and Standard Plans

Earlier development of the design standard and standard plans used by the Contractor could have resulted in greater efficiencies in time and money. These were used as the basis for the majority of the design. Problems occurred when the early phases of design, which were completed concurrently with the development of the design standards and standard plans, needed to be revised when changes were made to the standards and plans.

Performance Versus Prescriptive Specifications

The challenge of a Design/Build project is finding the right balance of the Contractor's capabilities and the Owner's responsibility. Specifications need to be written as end product specifications where possible, not prescriptive. This provides the Contractor more flexibility in the construction. Specifications should provide a toolbox approach to allow for innovation by the Design/Build Contractor.

Audits

It is important that an audit tracking system be set up at the beginning of the Design/Build process. It took UDOT several months to set up their tracking system. Prior to the system being set up, there was no record of the audit process for approximately six months of design. At the beginning of the Design/Build process, what the Owner wants checked should be clearly defined. This would provide an effective baseline for establishment of the Contractor's process. On this project, the Contractor completed detailed reviews of all work products and not just those being formally submitted to the Owner or actually used in the field. Some effort could have been reduced had Wasatch adopted a different audit policy.

The Design/Build Contractor's QC/QA program was more extensive than required by contract -- especially on earlier submittals when full QC/QA checks were completed when not really needed. UDOT only required complete reviews for 50% and 100% design completion. The Contractor required completing reviews at 30%, 65%, 90% and 100%. The general consensus was that they would probably not perform as detailed of a program for future projects.

Reviews

The contract provided for a seven-day turn around by UDOT on the final plan submittal. This time frame was not sufficient. More time should be provided for this process.

The Task Force approach, and weekly Comment Resolution Meetings, have been a significant benefit to the project's success. This has allowed for multiple agency involvement during development of the design and resulted in less comments and changes at later stages.

Staggered submittals should have been required in the contract. The Contractor worked with the I-15 UDOT Team on this, but were not required to do this by contract. However, for this project it has worked out.

Because of the magnitude of the number of bridges, UDOT felt there should have been more people involved on its part to review the bridges.

Processes for effectively coordinating field changes need to be established early. This process needs to be in place at the beginning of the project.

Impacts of Time Driven Schedules

Schedule was the major driving force in design and seemed to limit much of the design innovation. Although there may have been a better way to accomplish some elements, they were not considered if it meant compromising time limits. This is largely due to the fact that the award fee is primarily structured around meeting the schedule.

Owner Involvement

UDOT has been extremely committed to this project and the Design/Build process. They have actively attended all meetings and have participated throughout. UDOT has been very proactive thinking out-of-the-box and coordinating with the on-site staff. This has helped expedite the design schedule and issues resolution.